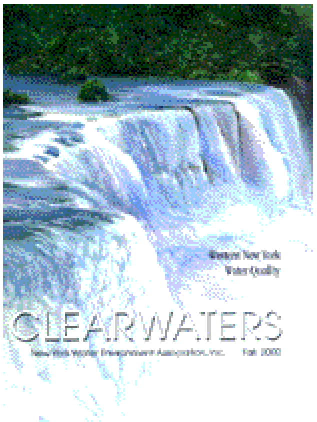

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Wasteland to parkland: the Cherry Farm / River Road Remediation

by John G. Goeddertz, PhD, James H. Kyles, and Mark S. Raybuck, PG

Quick reference

- Park design
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In a unique design, the construction of a ground water extraction system was integrated with the masterplan of a waterfront redevelopment effort on the shores of the Niagara River. The result: conversion of a polluted area, the Cherry Farm/River Road Site, into land suitable for a public park. The 79-acre Site had been used for the disposal of waste from steel manufacturing processes (1908-1963) and as an industrial landfill (1963-1970) (Parsons 1995). NYSDEC eventually designated the property as a hazardous waste site.

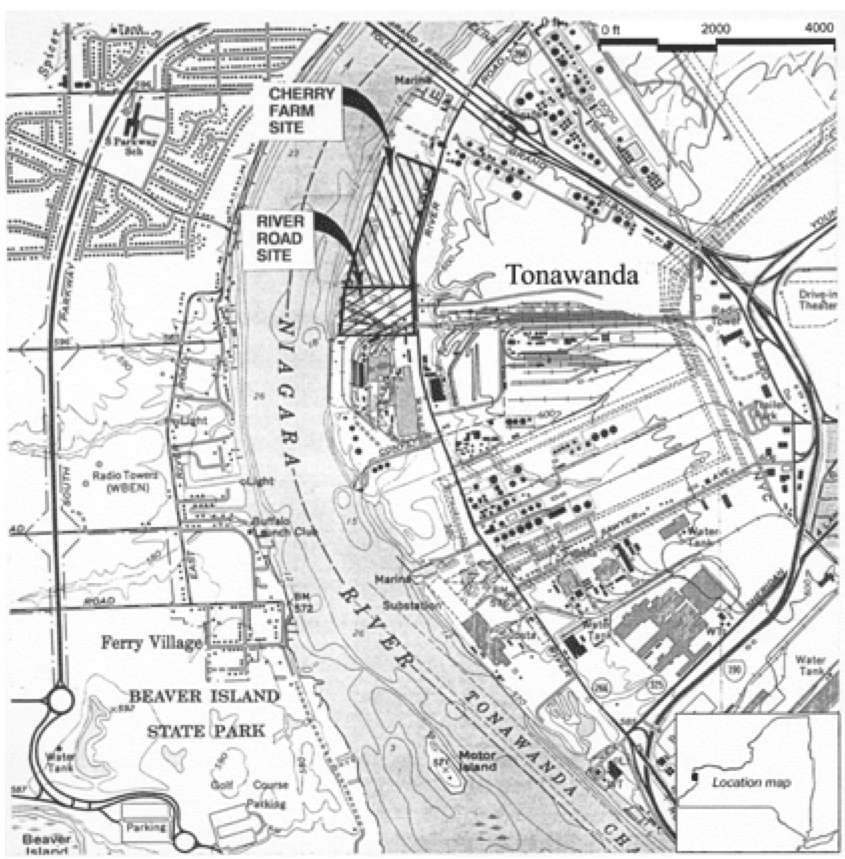


Figure 1. The Cherry Hill/River Road Site is in a highly industrialized

area on the eastern shore of the Niagara River 5 mi upstream of Niagara Falls in the Town of Tonawanda, NY.

One of the key cleanup objectives for the Site was to contain contaminated ground water and prevent discharge to the Niagara River from both a shallow and deep aquifer system. A comprehensive ground water extraction and treatment system was integral to the remediation process. Part of the prompting for this effort was the 1987 commitment to reduce toxic chemical input to the Niagara River by the NYS Department of Environmental Conservation (NYSDEC), the USEPA, the Ontario Ministry of Environment, and Environment Canada (NYSDEC 2000). The $10 million effort was financed by the Site's Potentially Responsible Parties (PRP) Group: Honeywell, General Motors, and Niagara Mohawk Power Corporation.

> **For some chemicals, the reductions observed [in the Niagara River] are due, in part, to the effectiveness of remedial activities at Niagara River sources in reducing chemical inputs to the river.**
> *—"Niagara River Toxics Management Plan" by the Niagara River Secretariat, June 2000*

The Site included waste disposal areas, a central drainage channel designated as a federal wetland, and several peripheral state and federal wetlands. Grasses and low-growing shrubs covered most of the area, with deciduous trees and brush on the steep embankment that forms the shoreline. Along the western boundary of the Site, the Tonawanda Channel of the Niagara River flows north around Grand Island, eventually joining the western channel of the Niagara River before plummeting over Niagara Falls. The river near the site is 1700 to 2000 ft wide. The main navigation channel is 21 ft deep (USACE 1994).

Soils, wetlands, and Niagara River sediments were affected in addition to the ground water. The extent of the contamination was quantified during several phases of a remedial investigation in the late 1980s and early 1990s (O'Brien & Gere 1989). Waste constituents were primarily polycyclic aromatic hydrocarbons (PAHs), metals, and polychlorinated biphenyls (PCBs). The PRP Group retained Parsons Engineering Science, Inc. to implement an extensive remedial design and construction program. Parsons worked from 1995 through 1999 together with the NYSDEC, the USACE, the Town of Tonawanda, and other local agencies to complete the project.

Remediation summary
- Waste consolidation
- Stabilization of the shoreline
- Removal and consolidation of affected sediments in drainage ditches
- Installation of permeable and impermeable barriers over the consolidated wastes, soil cover to support vegetation, and ground water extraction wells and collection trenches
- Collection and disposal of light nonaqueous phase liquids (LNAPL) in ground water
- Conveyance of ground water to an onsite treatment facility with subsequent discharge to the Town of Tonawanda publicly owned

treatment works (POTW)
- Wetlands mitigation
- Construction of three offshore barrier islands
- Development of terrestrial and aquatic habitats
- Enactment of deed restrictions affecting future use of the properties.

Remedial actions for sediment in the Niagara River
- Hydraulic dredging of 40,000 yd3 of sediment
- Mechanical dredging of 250 yd3 of sediment in a sensitive environment containing aquatic vegetation
- In-river capping for sediment that could not be removed due to shoreline slope stability

Park design

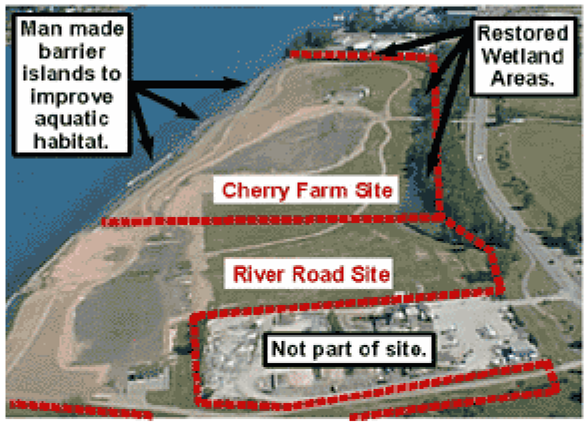
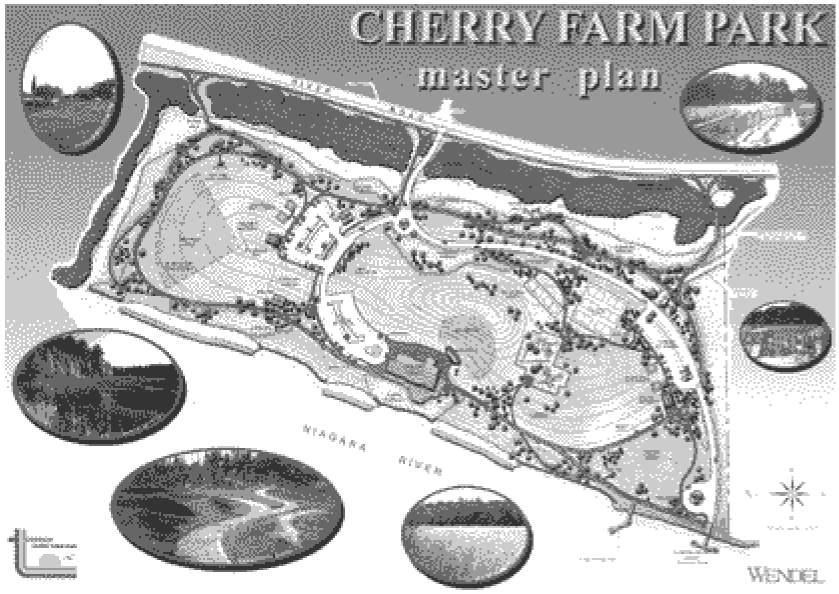


Figure 2. Remedial action construction was completed in September 1999. Operations, maintenance, and monitoring activities are ongoing, including O&M of the ground water extraction and treatment system.

The remedial action was performed not only to clean up the Site but also to enhance the shoreline and allow future development of the 57-acre Cherry Farm portion of the Site into a public park. To this end, Wendel Duchscherer Architects and Engineers, PC collaborated with Parsons on the remedial design to develop a master plan for a waterfront park development. A variety of active and passive recreational uses were incorporated in the design: open play fields, picnicking area and picnic shelters, playground, court games, general use areas, fishing site, floating transient dock with car top boat launch, main park facility with natural amphitheater and interpretive center, restrooms, maintenance garage, roadways, and parking. A pedestrian bridge and elevated nature walk areas will be constructed to connect Riverwalk users (a trail system that extends from Buffalo to Tonawanda) with a hierarchy of trail systems within the park.



Proposed layout of park (by Wendel Duchscherer)

The Site also affords visitors a spectacular view of the Niagara River, nearby Grand Island Bridge, and Grand Island itself. The PRP Group worked with the NYSDEC and USACE to enhance wildlife habitat along the shoreline adjacent to the river. The result was restoration of wildlife habitat lost through decades of industrial activity (Petrone, et al. 1999). The shoreline and offshore barrier islands were established with emergent marsh, submergent plants, and upland wooded vegetation to create several diverse fish and wildlife habitats. The wetland and habitat areas along the river's edge will be designated as limited access areas, and the use of jet skis and other powered watercraft will be prohibited (Wendel Duchscherer 1997). Finally, the PRP Group has provided much of the infrastructure needed for the planned park including "clean" zones within the fill material to accommodate future utility trenches and building foundations. At this time, the PRPs are negotiating with state and local agencies to work out details of the park development.

Containment system design

The containment system design provides the following:

Eleven deep zone extraction wells. Each well consists of a 6-inch stainless steel casing, a 4-inch submersible well pump with a variable speed drive, and high/low conductivity probes.

A shallow ground water extraction trench, located along the entire western perimeter of the Site parallel to the Niagara River. This system consisted of four segments of perforated collection pipe. Each segment of pipe drains into a concrete sump containing a submersible pump and high/low float control system. The river side of the shallow collection trench has an impermeable geomembrane to prevent migration of ground water to the river.

Click here for layout of wells

Conveyance system design

The ground water conveyance system consists of underground HDPE piping to convey collected ground water from the extraction wells and sumps to the treatment plant, with final discharge to the Town POTW. To facilitate long-term maintenance of the pumping system and because of the potential for scale buildup on the equipment from ground water, submersible recovery pumps with pitless adapters were installed. Also, clean-out ports and manholes were placed along the extraction trench to assist with system maintenance.

Treatment system design

Table 1 shows the characteristics of the ground water, the NYSDEC Class GA ground water cleanup standards, and the eventual discharge limits established by the Town. The Cherry Farm portion of the Site has relatively low levels of chemical constituents, and no parameters were present in excess of the Town's discharge standards. The River Road Site had low levels of volatile organic compounds, semivolatile organic compounds, and PCBs. LNAPL containing elevated concentrations of PCBs was present in monitoring wells on the River Road Site. In addition, ground water in some of the monitoring wells was highly alkaline. The Town provided Parsons with preliminary discharge limits of 10 parts per billion (ppb) total PCBs, and effluent pH of 6 to 8. No other parameters were deemed to require treatment by the Town. Based on the information available at the time, the plan was to treat water from the River Road Site by removing LNAPL and PCBs and to treat all the ground water to adjust pH.

Table 1. Summary of data for Cherry Farm/River Road ground water treatment plant: GW monitoring results

Parameter	Units	Cherry Farm Site	River Road Site	NYS guide (2)	Town POTW limit
pH	S.U.	7.2 - 10.6	6.4 - 10.0	N.A.	5.5 - 9.5
Total Organic Carbon	mg/l	14.8 - 27.5	27.4 - 113	N.A.	N.L.
BOD5	mg/l	N.D.	N.D. - 133	N.A.	250 *
COD	mg/l	44 - 65	76 - 4,960	N.A.	N.L.
Chloride	mg/l	6 - 50	36 - 104	N.A.	N.L.
Hardness	mg/l	136 - 842	1,020 - 1,090	N.A.	N.L.
Oil and Grease	mg/l	N.D.	N.D. - 2,660	N.A.	100
TSS	mg/l	29 - 130	132 - 188	N.A.	250 *
TDS	mg/l	252 - 1,170	1,960 - 2,020	N.A.	N.L.
Phenols	mg/l	N.D.	N.D. - 4.76	N.A.	N.L.
Ammonia - N	mg/l	1.13 - 2.27	12.4 - 14.5	N.A.	N.L.
Total Phosphorous - P	mg/l	N.D.	N.D. - 0.7	N.A.	6 *

Methylene Chloride	µg/l	N.D.	N.D. - 33	5	N.L.
1,1-Dichloroethane	µg/l	N.D.	N.D. - 460	5	N.L.
Toluene	µg/l	N.D.	N.D. - 530	5	N.L.
Ethylbenzene	µg/l	N.D.	N.D. - 110	5	N.L.
Naphthalene	µg/l	N.D.	N.D. - 70	10	N.L.
Acenapthene	µg/l	N.D.	N.D. - 56	20	N.L.
Fluorene	µg/l	N.D.	N.D. - 63	50	N.L.
Phenanthrene	µg/l	N.D.	N.D. - 250	50	N.L.
Fluoranthene	µg/l	N.D.	N.D. - 280	50	N.L.
Pyrene	µg/l	N.D.	N.D. - 150	50	N.L.
Chrysene	µg/l	N.D.	N.D. - 65	0.002	N.L.
bis(2-ethylhexyl) phthalate	µg/l	N.D.	N.D. -110	0.6	N.L.
Aroclor-1248	µg/l	N.D.	N.D. - 2,800	0.1	N.D.
Antimony	µg/l	N.D.	N.D. - 45.7	3	N.L.
Iron	µg/l	341 - 32,500	5,350 - 129,000	300	N.L.
Nickel	µg/l	N.D. - 31.8	N.D.	7.1	5000
Cyanide	µg/l	N.D. - 50	25 154	5.2	1100

Notes:
1. Only those parameters that were detected are presented.
2. Class GA ground water standatd
N.D. not detected N.A. not applicable N.L. no limit
* surcharge limit

Several bench-scale treatability studies were conducted to evaluate various treatment alternatives.

Objectives of treatability testing
-Determine if PCBs were associated with particulate matter or oils and determine appropriate removal technologies. If an emulsion was present, the effectiveness of various emulsion breaking techniques needed to be determined.
- Determine the volume of acid or caustic that would be required for full-scale pH neutralization of a variety of ground water discharge scenarios.
- Determine, qualitatively, if significant iron or calcium carbonate precipitation or scaling would be expected to occur in the treatment process.
- Establish optimal operating conditions for the selected technology.

Results of treatability testing
- Polymer addition with and without dissolved air flotation had little effect on LNAPL separation from collected ground water.
- Lowering the pH of ground water from the River Road Site to a pH of 2 with sulfuric acid (93%) resulted in the formation of a distinct yellow floating LNAPL layer. Removal of the LNAPL layer reduced the amount of PCBs in the ground water to approximately 3 ppb.
- Filtration was determined to be effective at PCB removal (nondetect to 7.6 ppb), but was not as effective as chemical treatment to remove

emulsified oil.
- Ground water is well buffered in an ideal pH range for discharge to the POTW (pH of 6 to 8).
- The accumulation of iron hydroxide and iron oxide solids was not a significant day-to-day problem, but periodic maintenance of the full-scale treatment and recovery equipment would be needed to manage the iron oxide precipitation.

Following the treatability testing, Parsons identified a treatment system consisting of acid cracking for the River Road recovery wells and the entire shallow trench followed by a coalescing plate oil-water separator. The acidified oil-free ground water would then be combined with ground water from the remaining recovery wells. The flow from this process would be discharged to the POTW. The highly alkaline ground water present in some of the Cherry Farm wells was sufficient to neutralize the acidified ground water based on the projected design flows.

New requirements

In late 1995, the treatability test results were presented to the Town in anticipation of obtaining a draft discharge permit. At the same time, the Great Lakes Initiative took effect and prohibited discharge of bioaccumulative compounds such as PCBs in any amount to Great Lakes receiving water bodies. The Town, therefore, altered its discharge limit for PCBs to the practical quantitation limit. The reduction of the discharge limit required addition of a granular activated carbon (GAC) system to the initial treatment concept.

Only the ground water that was treated by acid cracking was proposed to be passed through the GAC. The use of acidification to break the oil and water emulsion turned out to be beneficial from a cost perspective, because it allowed the use of GAC without employing an iron removal step before the GAC. Acidifying the influent water maintains the iron in a dissolved state, thus eliminting precipitation and clogging of the carbon filters. If acid cracking were not used, iron precipitation, clarification, and sludge dewatering would have been required.

Acidification process

Flow in which LNAPL and/or PCBs was discovered was routed to the acidification tank (Figure 5). Recovery wells that showed no PCBs were not routed through the acidification process. Technical grade sulfuric acid is added to the acidification tank by a metering pump, which is controlled by a proportional pH controller. The retention time in the acidification tank was designed to be 5 min (actual retention time is 20 min). The pH in the acidification tank is controlled between 1.9 and 2.0 and typically results in a visible oil sheen on the water. Acidified water and oil flows by gravity to the oil/water separator, which contains a coalescing pack that effectively removes the free-phase oil.

The pH 2 water is then pumped by a duplex pump system through a 25-µ prefilter, dual GAC beds (1700 lb each), and a 25-micron post filter. The GAC columns were sized for an empty bed contact time of 20 min (actual retention time is 40 min). Following the GAC columns, the pH 2 water passes through a post-filter to collect any stray carbon particles before it is discharged to the equalization tank. In the equalization tank the pH 2 water is combined with ground water from the remaining recovery wells.

Click here for treatment plant process layout

Anticipating the park One element of the pump and treat system was unique because of the anticipated use of the Site as a park. Each recovery well and sump was installed in a totally enclosed concrete vault with lockable aluminum access doors. The vault covers are flush with grade. Protruding above the surface is a 10-ft well casing vent, and a 1-ft candy cane vault vent. All electrical power and control equipment for each well and sump is installed in the vault.

Although this installation is ideal for the park setting, it has led to O&M problems as a result of moisture accumulation in the vaults. During cold weather, condensation on surfaces has led to failure of motor starters, contacts, and transformers. Heaters have been placed in the most troublesome vaults to prevent condensation.

Although the treatability study showed that combining the acidified effluent with the remaining site ground water would effectively neutralize the ground water, a pH controller was provided in the equalization tank with acid and base addition to enable fine-tuning of the effluent and thus to meet the POTW's discharge limits. (V-notch primary flow device and ultrasonic flow meter were incorporated in the equalization tank along with an automatic composite sampler to enable flow monitoring and flow proportional sample collection of the combined ground water.

The treatment plant is equipped with a conventional control panel that employs an autodialer to alert the operations staff of any alarm conditions. Operations personnel carry a dedicated pager that receives messages from the treatment plant's autodialer.

Discharge permit The Town of Tonawanda issued a discharge permit to the PRP Group with Parsons designated as the authorized party responsible for submitting monthly reports. The initial 6-month permit specified the following:
- Perform a PCB effluent method detection limit study. The practical quantitation limit then became the discharge limit.
- Perform weekly monitoring of the GAC column effluent before combining with the other recovery wells, for PCBs, and oil and grease.
- Perform weekly monitoring of the combined plant effluent for PCBs, and oil and grease.
- Perform monthly monitoring of the final plant effluent for conventional parameters and sewer use ordinance metals.
- Monitor the total plant effluent for priority pollutants once in 6 months.
- Based upon the results for the first 6 months of operation, a permanent discharge permit was issued that included some relaxation of the monitoring requirements.

Monitoring requirements:

Monthly Final plant effluent and GAC effluent for PCBs and oil and grease. Skimmed oil for PCBs

Semiannually	Final plant effluent for conventional pollutants and iron
Annually	Final plant effluent for priority pollutants

Operation and effectiveness

The Cherry Farm River Road treatment plant has been operating since August 1997. It has complied fully with the pretreatment permit. Typical concentrations of effluent parameters are presented in Table 2. Total flow through the system has stabilized at 25 gal/min, with half of the flow passing through the acidification process and the remainder coming from other recovery wells. Table 2 shows the values that typically characterize the effluent.

Table 2. Typical concentrations of effluent parameters

Parameters	Units	Cherry Farm Site
pH	S.U.	6.0 - 7.0
BOD5	mg/l	N.D. - 4
COD	mg/l	25 - 42
Oil and Grease	mg/l	N.D.
TSS	mg/l	16 - 73
Total Phosphorous - P	mg/l	0.22 - 0.32
Iron	mg/l	6.6 - 10.7
PCBs	µg/l	N.D.
LNAPL - oil skimmings, Aroclor 1260	µg/l	N.D. - 18,000

Figure 6. Interior of Cherry Farm River Road treatment plant

Based on monthly water level elevations and ground water contour plots, the extraction system has effectively prevented ground water discharge to the Niagara River. The system was designed, however, to accommodate potential variations in ground water recharge caused by climatic changes or water level fluctuations in the river; these fluctuations are heavily influenced by Lake Erie water levels. In October 1998, the target drawdown level in all recovery wells was lowered by 4 ft with minimal effort to improve the capture zones of the wells.

During the 3 yr of operation, the GAC vessels have not been changed, and 200 gal of LNAPL has been collected. The LNAPL is monitored monthly and has been found to contain elevated concentrations of PCBs.

The method of emulsion breaking employed at this facility is cumbersome because concentrated sulfuric acid is used followed by neutralization of the combined effluent with 50% sodium hydroxide. This method enables the iron to pass through the activated carbon and remain in a soluble state. The carbon beds, while showing no signs of PCB breakthrough, have steadily built up head loss as measured by the pressure differential across the column. However, a 3-yr run time, without providing pretreatment for iron removal, is exceptional considering the levels of iron present in the influent. The tradeoff must be measured in terms of chemical consumption, with current acid consumption at 10 to 15 gal/day and caustic consumption at 20 to 25 gal/day. Caustic consumption has been higher than predicted during the treatability study because of lower than anticipated pumping rates (and consequently less neutralization of the acidified ground water) achieved in some recovery wells.

The cost of increased chemical consumption still outweighs the benefit of operating an iron removal process, however. The benefit is realized in terms of capital cost savings and reduced maintenance. Currently, the facility is staffed for 16 hr/week. If an iron removal process were used, operator labor would increase to 40 hr/week.

Conclusions

Creation of green spaces from former industrial properties will continue to be an important issue in western New York State for many years. Fortunately, regulatory programs over the past decade have led to significant source reductions and measurably cleaner water in the Niagara River. The Cherry Farm/River Road remediation demonstrates the following features:

- Cleaning up sites affected by past waste disposal practices
- Adding substantial value by integrating the remediation with end uses that benefit the public
- Restoring and improving terrestrial and aquatic ecosystems. As a result of this environmental cleanup, wildlife species are returning. (See blue herons in Figure 7.)

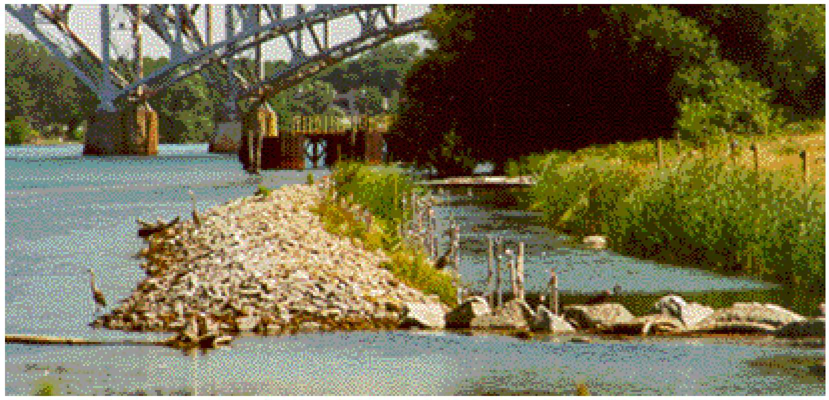


Figure 7. Restored habitat — part of remediation efforts

This project illustrates the need for active cooperation and collaboration among major industry, local, state, and federal regulatory agencies, environmental specialists, and the public. Operation and maintenance of the treatment system after the park is developed and open to the public will require further cooperation among these parties to ensure protection of human health and environment and a long-term beneficial use of the property.

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